

## WHAT IS CLAIMED IS:

1. A free-cutting tool steel containing Fe as a major component and C in an amount of 0.1 to 2.5 wt%;

5 containing Ti and/or Zr so that  $W_{Ti} + 0.52W_{Zr}$  amounts to 0.03 to 3.5 wt%, where  $W_{Ti}$  represents Ti content (wt%) and  $W_{Zr}$  represents Zr content (wt%);

containing at least any one of S, Se and Te so that  $W_s + 0.4W_{Se} + 0.25W_{Te}$  amounts to 0.01 to 1.0 wt%, and so that

10  $(W_{Ti} + 0.52W_{Zr}) / (W_s + 0.4W_{Se} + 0.25W_{Te})$  amounts to 1 to 4, where  $W_s$  represents S content (wt%),  $W_{Se}$  represents Se content (wt%) and  $W_{Te}$  represents Te content (wt%); and

15 having dispersed in a texture thereof a machinability improving compound phase within a range from 0.1 to 10% in terms of area ratio in a section;

15 said machinability improving compound phase comprising a metallic element component having Ti and/or Zr as major components, and a binding component for such metallic element component essentially containing C and also containing any one of S, Se and Te.

2. The free-cutting tool steel according to Claim 1, wherein said machinability improving compound phase mainly comprises a component phase expressed by a composition formula  $M_4Q_2C_2$  (where M represents the metallic element component mainly comprises Ti and/or Zr, and Q represents at least any one of S, Se and Te).

3. The free-cutting tool steel according to Claim 1 further containing any one element selected from Mn in an amount of 2.0 wt% or less, Ni in an amount of 2.5 wt% or less, Cr in an amount of 17 wt% or less, Mo and/or W so that 5 Mo + 0.5W amounts to 12 wt% or less, V in an amount of 6 wt% or less, and Co in an amount of 15 wt% or less.

4. The free-cutting tool steel according to Claim 1 wherein Si amount is 2.0 wt% or less, Al amount is 0.1 wt% 10 or less and N amount is 0.040 wt% or less.

5. The free-cutting tool steel according to Claim 1 further containing any one element selected from Ca in an amount of 0.0050 wt% or less, Pb in an amount of 0.2 wt% or 15 less, Bi in an amount of 0.2 wt% or less, Nb and/or Ta so that Nb + 0.5Ta amounts to 0.05 wt% or less, and a rare earth metal in an amount of 0.50 wt%.

6. The free-cutting tool steel according to Claim 1 20 containing C in an amount of 0.1 to 0.6 wt%; and containing at least any one element selected from Mn in an amount of 2.0 wt% or less, Ni in an amount of 1.0 wt% or less, Cr in an amount of 3 wt% or less, Mo and/or W so that Mo + 0.5W amounts to 1.0 wt% or less, V in an amount of 25 0.5 wt% or less, and Co in an amount of 1.0 wt% or less.

7. The free-cutting tool steel according to Claim 6 used as a source material for die for molding plastics.

8. The free-cutting tool steel according to Claim 1 containing C in an amount of 0.2 to 0.6 wt%;

5 essentially containing Cr in an amount of 0.3 to 7 wt%; and

10 containing at least any one element selected from Mn in an amount of 2.0 wt% or less, Ni in an amount of 2.5 wt% or less, Mo and/or W so that Mo + 0.5W amounts to 4.0 wt% or less, V in an amount of 2 wt% or less, and Co in an amount of 5.0 wt% or less.

9. The free-cutting tool steel according to Claim 8 used as a source material for hot forming die.

15 10. The free-cutting tool steel according to Claim 1 containing C in an amount of 0.3 to 1.8 wt%; and

20 containing at least any one element selected from Cr in an amount of 4 wt% or less, Mn in an amount of 2.0 wt% or less, Ni in an amount of 2.5 wt% or less, Mo and/or W so that Mo + 0.5W amounts to 2.5 wt% or less, V in an amount of 1 wt% or less, and Co in an amount of 1.0 wt% or less.

25 11. The free-cutting tool steel according to Claim 10 used as a source material for cold forming die, cutting tool or impact-resistant tool.

12. The free-cutting tool steel according to Claim 1 containing C in an amount of 0.5 to 2.5 wt%;

essentially containing Cr in an amount of 4 to 17 wt%;  
and

5 containing at least any one element selected from Mn  
in an amount of 2.0 wt% or less, Ni in an amount of 1.0 wt%  
or less, Mo and/or W so that Mo + 0.5W amounts to 1.5 wt% or  
less, V in an amount of 1 wt% or less, and Co in an amount  
of 1.0 wt% or less.

10 13. The free-cutting tool steel according to Claim  
12 used as a source material for cold forming die.

14. The free-cutting tool steel according to Claim 1  
containing C in an amount of 0.5 to 2.0 wt%;  
15 containing at least any three elements selected from  
Cr as an essential element in an amount of 3 to 7 wt%, Mo  
and/or W as an essential element so that Mo + 0.5W amounts  
to 4 to 12 wt%, V as an essential element in an amount of  
0.5 to 6.0 wt%, Mn in an amount of 2.0 wt% or less, Ni in an  
amount of 1.0 wt% or less, and Co in an amount of 15.0 wt%  
20 or less.

16. The free-cutting tool steel according to Claim  
14 used as a source material for cutting tool, cold forming  
die or hot forming die.

25 16. A free-cutting tool steel containing Fe as a  
major component and C in an amount of 0.001 to 0.6 wt%; and  
further containing Ni in an amount of 6 wt% or less,

Cu in an amount of 5 wt% or less, and Al in an amount of 3 wt% or less;

wherein such tool steel further contains:

Ti and/or Zr so that  $X$  (wt%) =  $W_{Ti} + 0.52W_{Zr}$  amounts to 5 0.03 to 3.5 wt%, where  $W_{Ti}$  represents Ti content (wt%) and  $W_{Zr}$  represents Zr content (wt%);

at least any one of S, Se and Te so that  $Y$  (wt%) =  $W_S + 0.4W_{Se} + 0.25W_{Te}$  amounts to 0.01 to 1 wt%, where  $W_S$  represents 10 S content (wt%),  $W_{Se}$  represents Se content (wt%) and  $W_{Te}$  represents Te content (wt%); and

having dispersed in a texture thereof a machinability improving compound phase;

said machinability improving compound phase comprising a metallic element component having Ti and/or Zr as major 15 components, and a binding component for such metallic element component essentially containing C and also containing any one of S, Se and Te.

17. The free-cutting tool steel according to Claim 20 16, wherein the values X and Y are defined so as to satisfy a relation of  $1 \leq X/Y \leq 4$ .

18. The free-cutting tool steel according to Claim 25 16, wherein said machinability improving compound phase mainly comprises a component phase expressed by a composition formula  $M_4Q_2C_2$  (where M represents the metallic element component mainly comprises Ti and/or Zr, and Q represents any one of S, Se and Te).

19. The free-cutting tool steel according to Claim  
16 having a ratio of Charpy impact values  $I_T/I_L$  of 0.3 or  
above, where

5  $I_T$  is a Charpy impact value of a T-directional test  
piece and  $I_L$  is a Charpy impact value of an L-directional  
test piece:

said impact values being obtained in Charpy impact  
test specified by JIS Z2242; and

10 said T-directional test piece and L-directional test  
piece being fabricated as No. 3 test pieces specified in JIS  
Z2202 by notching a forged-and-rolled product of such tool  
steel along the directions parallel to and normal to the  
forging-and-rolling direction, respectively.

15 20. The free-cutting tool steel according to Claim  
16, wherein said machinability improving compound phase  
observed in a polished surface of such tool steel has an  
area ratio of 0.1 to 10%.

20 21. The free-cutting tool steel according to Claim  
16 satisfying relations of

$$0.2X \leq Y \leq X; \text{ and}$$

$$0.07X \leq W_C \leq 0.75X$$

25 where  $W_C$  represents C content (wt%).

22. The free-cutting tool steel according to Claim  
16 containing Cr in an amount of 22 wt% or less; and

containing at least any one element selected from Mo and/or W so that  $W_{Mo} + 0.5W_W$  amounts to 4 wt% or less, where  $W_{Mo}$  represents Mo content (wt%) and  $W_W$  represents W content (wt%), Mn in an amount of 3 wt% or less, Co in an amount of 5 2 wt% or less, Nb in an amount of 1 wt% or less and V in an amount of 1 wt%.

23. The free-cutting tool steel according to Claim 16 wherein Si amount is 2 wt% or less, N amount is 0.04 wt% 10 or less, and O amount is 0.03 wt% or less.

24. The free-cutting tool steel according to Claim 16 further containing Ca in an amount of 0.005 wt% or less, Pb in an amount of 0.2 wt% or less, Bi in an amount of 0.2 15 wt% or less, Ta in an amount of 0.05 wt% or less, B in an amount of 0.01 wt% or less, and a rare earth metal element in an amount of 0.5 wt% or less.

25. The free-cutting tool steel according to Claim 16 containing C in an amount of 0.001 to 0.4 wt%, Cu in an 20 amount of 0.5 to 5 wt%, Ni in an amount of 1 to 5 wt%, and Al in an amount of 0.5 to 3 wt%; and wherein Cr amount is 10 wt% or less.

26. The free-cutting tool steel according to Claim 16 containing Cr in an amount of 10 to 22 wt%.

27. The free-cutting tool steel according to Claim

16 used as a source material for die for molding plastics.